

## CONTENTS

	Page
FIGURES .....	vi
TABLES .....	vii
EXECUTIVE SUMMARY .....	ix
ABSTRACT .....	1
1. INTRODUCTION .....	1
1.1 The Technologies .....	2
1.1.1 Ultrawideband Transmission Systems .....	2
1.1.2 Public Safety Radio Systems .....	3
1.2 Scope .....	3
1.3 Organization of this Report .....	3
2. SIGNAL CHARACTERISTICS .....	5
2.1 Public Safety LMR Systems .....	5
2.2 UWB Signals .....	5
3. MEASUREMENT SYSTEM AND PROCEDURES .....	9
3.1 System .....	9
3.1.1 LMR Source Segment .....	11
3.1.2 UWB Source Segment .....	11
3.1.3 CW Source Segment .....	13
3.1.4 Noise Source Segment .....	13
3.1.5 LMR Receiver Segment .....	13
3.2 Measurement Procedure .....	15
3.2.1 Digital-modulation (P25) Radio Receiver Measurement Procedure .....	15
3.2.2 Analog FM Radio Receiver Measurement Procedure .....	16
3.3 Power Measures, Settings, Calibration and Frequency Precision .....	18
3.3.1 Calibration and Power Level Correction .....	18
3.3.2 Frequency Precision .....	19
4. MEASUREMENT RESULTS .....	20
4.1 Description of Compiled Measurement Results .....	20
4.2 Summary of Measurement Results .....	34
5. CONCLUSION .....	35
6. ACKNOWLEDGMENTS .....	37

7. REFERENCES .....	37
8. ACRONYMS .....	38
APPENDIX: CHARACTERISTICS OF GENERATED UWB SIGNALS .....	A-1
A.1 Signal Description .....	A-1
A.2 Residual Spectral Effects due to Signal Generation .....	A-2

## FIGURES

	Page
Figure 2.1. Pulse spacing modes. ....	6
Figure 2.2. Spectral characteristics of the different pulse spacing modes. ....	7
Figure 2.3. Temporal plots of 50%-ARD UWB signals passed through a 20-MHz bandpass filter and downconverted to an intermediate frequency. ....	8
Figure 3.1. Public Safety radio interference test bed. ....	9
Figure 3.2. Block diagram of measurement system. ....	10
Figure 3.3. Frequency histogram of the C4FM modulated signal. ....	11
Figure 3.4. Input impedance to receiver A as seen at the input to the matching stub. ....	14
Figure 3.5. Input impedance to receiver B as seen at the input to the matching stub. ....	14
Figure 3.6. Basic block diagram for digital modulation radio receiver measurement. ....	15
Figure 3.7. Basic block diagram for analog radio receiver measurement. ....	17
Figure 4.1. In-band interference rejection ( $P_{\text{REF}} - P_i$ ). ....	21
Figure 4.2. Percent bit-error versus variable interference power density for Receiver A in P25 mode – 100-kHz PRF UWB interference. ....	25
Figure 4.3. Percent bit-error versus variable interference power density for Receiver A in P25 mode – 20-MHz PRF UWB interference. ....	25
Figure 4.4. Percent bit-error versus variable LMR power for Receiver A in P25 mode – 100-kHz PRF UWB interference. ....	26
Figure 4.5. Percent bit-error versus variable LMR power for Receiver A in P25 mode – 20-MHz PRF UWB interference. ....	26
Figure 4.6. Percent bit-error versus variable interference power density for Receiver B in P25 mode – 100-kHz PRF UWB interference. ....	27
Figure 4.7. Percent bit-error versus variable interference power density for Receiver A in P25 mode – 20-MHz PRF UWB interference. ....	27
Figure 4.8. Percent bit-error versus variable LMR power for Receiver B in P25 mode – 100-kHz PRF UWB interference. ....	28
Figure 4.9. Percent bit-error versus variable LMR power for Receiver B in P25 mode – 20-MHz PRF UWB interference. ....	28
Figure 4.10. Average SINAD versus variable interference power density for Receiver B in analog mode – 100-kHz PRF UWB interference. ....	29
Figure 4.11. Average SINAD versus variable interference power density for Receiver B in analog mode – 20-MHz PRF UWB interference. ....	29

Figure 4.12.	Average SINAD versus variable LMR power for Receiver B in analog mode – 100-kHz PRF UWB interference. ....	30
Figure 4.13.	Average SINAD versus variable LMR power for Receiver B in analog mode – 20-MHz PRF UWB interference. ....	30
Figure 4.14.	Percent bit-error versus S/I for Receiver A in P25 mode – 100-kHz PRF UWB interference. ....	31
Figure 4.15.	Percent bit-error versus S/I for Receiver A in P25 mode – 20-MHz PRF UWB interference. ....	31
Figure 4.16.	Percent bit-error versus S/I for Receiver B in P25 mode – 100-kHz PRF UWB interference. ....	32
Figure 4.17.	Percent bit-error versus S/I for Receiver B in P25 mode – 20-MHz PRF UWB interference. ....	32
Figure 4.18.	Average SINAD versus S/I for Receiver B in analog mode – 100-kHz PRF UWB interference. ....	33
Figure 4.19.	Average SINAD versus S/I for Receiver B in analog mode – 20-MHz PRF UWB interference. ....	33
Figure A-1.	Discrete binning of pulse position for clock referenced dithering. ....	A-3
Figure A.3.	Spectral lines due to discrete binning of pulse position. ....	A-3

## TABLES

Table 3.1.	UWB Signal Space .....	12
Table 4.1.	In-band Interference Rejection ( $P_{\text{REF}} - P_I$ ) in dB .....	20
Table 4.2.	Power Correction Factors (dB) .....	24
Table A-1.	Characteristics of Generated UWB Signals .....	A-1